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METHOD AND APPARATUS FOR ASSEMBLING SUBSTRATE

[Abstract]

PROBLEM TO BE SOLVED: To provide a method for assembling a substrate by which the substrate can reliably be assembled, and to provide an apparatus for the same.

SOLUTION: The apparatus for assembling a substrate has a means to hold the whole area of another substrate by suction adsorption by a pressure plate in the atmosphere, a means to mechanically hold the intermediate parts of a set of opposite sides in the other substrate, a means which releases the suction

adsorption at the side of the remaining opposite sides in the other substrate to makes each side into a free end, and then releases the suction adsorption over both intermediate parts of the set of the opposite sides, a means to apply a voltage for electrostatic adsorption to the pressure plate when a vacuum chamber is set at a desired vacuum, and a means to hold the whole area of the other substrate by the electrostatic adsorption of the pressure plate by holding successively the remaining opposite sides which are the free ends of the other substrate held over both intermediate parts of the set of opposite sides by the electrostatic adsorption of the pressure plate by the electrostatic adsorption of the pressure plate.

【Claims】

【Claim 1】

A method for assembling substrates, wherein one substrate of a pair of substrates attached to each other is arranged on a table located at lower side in a vacuum chamber, and the other substrate is maintained by electrostatic absorption to a pressurizing plate located in the vacuum chamber, the plate opposing to a substrate loading surface of the table, and wherein respective substrates are attached to each other by reducing a distance formed between the substrates in vacuum and by using adhesives applied on any one surface of the respective substrates, *the assembling method is characterized in* that the other substrate is formed to protrude as a bow having a cylindrical surface wherein an upper surface becomes an outer side in an atmosphere, and a mid-portion of the upper surface is maintained by performing electrostatic absorption to the pressurizing plate in a reduced pressure atmosphere, and after maintaining an edge of the other substrate which becomes a free end by electrostatic absorption with the pressurizing plate, and maintaining a remaining edge of the other substrate which becomes a free end by electrostatic absorption with the pressurizing plate, whereby opposing the other substrate to the one substrate by maintaining the other substrate over whole surfaces through electrostatic absorption with the pressurizing plate.

【Claim 2】 A method for assembling a substrate, wherein one substrate of a pair of substrates attached to each other is arranged on a table located at lower side in a vacuum chamber, and the other substrate is maintained by electrostatic absorption to a pressurizing plate located in the vacuum chamber, the plate opposing to the a substrate loading surface of the table, and wherein respective

substrate are attached to each other by reducing a distance formed between the substrates in vacuum and by using adhesives applied on any one surface of the respective substrate, *the assembling method is characterized in* that the other substrate is maintained over an entire surface thereof by performing suction absorption the other substrate to the pressurizing plate in an atmosphere, and a mid-portion of the other substrate which is located between a pair of opposing edges is maintained mechanically, and wherein the suction absorption of the remaining opposing edges is relieved to thereby make a respective edge to be a free end, and suction absorption applied to the mid-portion located between the pair of opposing edges is relieved, and progressing vacuum forming in the vacuum chamber to achieve a desired vacuum degree, and then applying electric voltage for electrostatic absorption to the pressurizing plate to thereby maintain the other substrate by positioning the other substrate to the mid-portion of the pair of opposing edges and performing electrostatic absorption with the pressurizing plate, and maintaining the remained respective edge, which becomes a free end, by electrostatic absorption to the pressurizing plate in sequence to thereby oppose the one substrate supporting over an entire surface to the other substrate by performing electrostatic absorption with the pressurizing plate.

【Claim 3】 The method of Claim 1, wherein the suction absorption performed to the mid-portion between the pair of opposing edges is relieved, after mechanically maintaining the mid portion at a lower portion of the location of the mid portion mechanically supporting one end which becomes a free end of the pair of opposing edges of the other substrate.

【Claim 4】 The method of claim 1 or claim 2, wherein the respective edge portion of the substrate which becomes a free end is electrostatic absorbed by the pressurizing plate after being ascended to a location where the electrostatic absorption force of the pressurizing plate reaches.

【Claim 5】 An apparatus for assembling substrates, wherein one substrate to be attached is arranged on a table located at lower side in a vacuum chamber, and the other substrate is maintained by electrostatic absorption to a pressurizing plate located in the vacuum chamber, the plate opposing to the a substrate loading surface of the table, and wherein respective substrates are attached to each other by reducing a distance formed between the substrates in vacuum and by using adhesives applied on any one surface of the respective substrate, the apparatus is characterized by comprising: means for maintaining the other substrate over an entire surface in an atmosphere by performing electrostatic absorption with the pressurizing plate; means for mechanically maintaining a mid-portion of the other substrate between a pair of opposing edges of the other substrate; means for relieving the suction absorption applied over the mid-portion of the pair of opposing edges after relieving the suction absorption of the remained opposing edges in the other substrate to make the respective edge be free end; means for applying electric voltage for electrostatic absorption to the pressurizing plate after achieving a desired degree of vacuum in the vacuum chamber; and means for supporting the other substrate over an entire surface thereof through performing electrostatic absorption with the pressurizing plate by maintaining the remained opposing edges of the other substrate, which become free ends, by means of performing electrostatic absorption with the pressurizing plate in sequence, the other substrate being maintained to be absorbed by

suction absorption in the mid-portion thereof of the pair of opposing edges with the pressurizing plate.

【Claim 6】 The apparatus of claim 5, wherein the pressurizing plate includes means for performing suction absorption of an area formed of the mid portion between the pair of opposing edges of the other substrate, and means for performing suction absorption of an area formed at respective remained opposing edges of the other substrate.

[Title of the invention]

METHOD AND APPARATUS FOR ASSEMBLING SUBSTRATE

【Detailed Description of the Invention】

【001】

【Field of the Invention】

The present invention relates to a method for assembling a substrate and an apparatus for assembling the substrate, in which the substrate used for liquid crystal panel and the like is stuck in an vacuum chamber.

【002】

【Description of the Prior Art】 As for an assembling process of a liquid crystal display panel, there has been included an substrate assembling process in which a space having a distance of some μm between the substrates is prepared between two sheets of glass substrates made of transparent electrodes or TFT (thin film transistor) array and the like, and the liquid crystal is sealed into the space. The substrate assembling process is disclosed in Japanese Patent Application Laid Open No. 2000-284295. The conventional substrate assembling process will be explained below.

【003】 At first, sealing materials are applied to enclose a surface along an periphery edge of a substrate, and the liquid crystal is dropped to inner side of the substrate. In this instance, the liquid crystal dropped on the substrate is sealed not to leak out from the surface of the substrate by the sealing materials.

【004】 Then, the substrate (herein-after, it is called as a lower substrate) is arranged on a lower table (hence it is called as a table), and it is fixed on the table by static absorption, and at the same time, an other side substrate (hereinafter it

is called as an upper substrate), which is stuck to the opposing substrate, is maintained to an upper table (herein-after it is called as a pressurized plate) which is positioned above the table by static absorption.

【005】 After completing these process, the position of the two substrates is determined, and then sticking is performed using the actual adhesion force by comparatively moving the one table pressurizing plate to the other plate. In this instance, the substrate can be stuck after the adhesives are applied on an actual peripheral position. Then, the two sheets of glass substrates (herein-after they are called as cells) between which the liquid crystal has been sealed can be assembled.

【006】 Next, an absorption process of the assembling process in which the upper substrate is electrostatic absorbed to the pressurizing plate will be explained below. It is performed by suction absorbing the upper substrate to the pressurizing plate in an atmosphere with supporting the peripheral edge of the upper substrate by means of the supporting apparatus, and making the upper substrate close to the pressurizing plate, and then performing pressure reduction (forming vacuum) in the vacuum chamber, and converting the suction absorption into the electrostatic absorption to a desired vacuum degree. Further, because several functional films for marking have been arranged on the lower surface of the upper substrate, when something is contacted, the functional films can be damaged. Therefore, the peripheral edge of the substrate is maintained to be fixed at the time of moving the substrate.

【007】

【Problems to be solved by the Invention】 However, in the process of pressure reduction in the vacuum chamber, the upper substrate has been forced by the

discharge of small amounts of air contained between the upper substrate and the pressurizing plate to thereby move or drop the upper substrate of the pressurizing plate.

【008】 Further, when small amounts of air remain between the upper substrate and the pressurizing plate, electric discharge is produced between the electrostatic absorption electrode of the pressurizing plate and the upper substrate according to the conditions of voltage applied for electrostatic absorption or vacuum degree of the remained air, or the distance between the upper substrate and the pressurizing plate and the like, as a result, the upper substrate falls because the electrostatic absorption force becomes extinct due to the extinction and migration of the electric charge during the discharge.

【009】 In this instance, in order to overcome the above explained problems arising from the prior art, it has been suggested that vacuum is formed in the vacuum chamber with supporting the peripheral edge of the upper substrate, and when the vacuum degree is achieved to be below a desired degree, the upper substrate is made close to the pressurizing plate to make the upper substrate to be electrostatic absorbed to the pressurizing plate.

【0010】 However, in this case, as the size of the substrate becomes bigger to be thinner, the upper substrate is made to be bent to lower direction by its weight at the mid portion to maintain the peripheral edges, so that the upper substrate can not be accurately electrostatic absorbed to the pressurizing plate because the electrostatic absorption force can not be applied to the mid portion, although the peripheral edges press down the pressurizing plate. Further, in case of the small substrate size, as the mid portion formed by supporting the peripheral edges are small, the upper substrate may be absorbed to the pressurizing plate from the

peripheral edge of the substrate to the mid portion thereof, and there remains distortion in the absorbed glass substrate. When the distortion remains as stated above, the cell can be damaged by light stress or impact force or the display function of the liquid crystal panel in the cell is deteriorated.

【0011】 An object of the present invention is to overcome above explained problems arising from the prior art, and to provide an assembling method of a substrate and an apparatus for assembling it, in which the substrate can be assembled accurately without any damages remained in the substrate, although the substrate becomes larger and thinner.

【0012】

【Means for Solving the Problem】 To achieve above object of the present invention, according to the invention described in claim 1, one substrate of a pair of substrates stuck to each other is arranged on a table located at lower side in a vacuum chamber, and the other substrate is maintained by electrostatic absorption to a pressurizing plate located in the vacuum chamber, the plate opposing to the a substrate loading surface of the table, and wherein respective substrate are stuck to each other by reducing intervals formed between the substrates in vacuum and by using adhesives applied on any one surface of the respective substrate, the assembling method is characterized in that the other substrate is formed to protrude as a bow having a cylindrical surface wherein an upper surface becomes an outer side in an atmosphere, and a mid portion of the upper surface is maintained by performing electrostatic absorption to the pressurizing plate in a reduced pressure atmosphere, and after maintaining an edge of the other substrate which becomes a free end by electrostatic absorption with the pressurizing plate, and maintaining a remaining edge of the other

substrate which becomes a free end by electrostatic absorption with the pressurizing plate, whereby opposing the other substrate to the one substrate by maintaining the other substrate over whole surfaces through electrostatic absorption with the pressurizing plate.

【0013】 Furthermore, according to the invention described in claim2, one substrate is arranged on a table located at lower side in a vacuum chamber, and the other substrate is maintained by electrostatic absorption to a pressurizing plate located in the vacuum chamber, the plate opposing to the a substrate loading surface of the table, and wherein respective substrate are stuck to each other by reducing intervals formed between the substrates in vacuum and by using adhesives applied on any one surface of the respective substrate, the assembling method is characterized in that the other substrate is maintained over whole surfaces thereof by performing suction absorption the other substrate to the pressurizing plate in an atmosphere, and a mid portion of the other substrate which is located between a pair of opposing edges is maintained mechanically, and wherein the suction absorption of the remaining opposing edges is relieved to thereby make respective edge to be a free end, and suction absorption applied to the mid portion located between the pair of opposing edges is relieved, and progressing vacuum forming in the vacuum chamber to achieve a desired vacuum degree, and then applying electric voltage for electrostatic absorption to the pressurizing plate to thereby maintain the other substrate by positioning the other substrate to the mid portion of the pair of opposing edges and performing electrostatic absorption with the pressurizing plate, and maintaining the remained respective edge, which becomes a free end, by electrostatic absorption to the pressurizing plate in sequence to thereby oppose the one substrate supporting

over whole surfaces to the other substrate by performing electrostatic absorption with the pressurizing plate.

【0014】 According to the invention described in claim 3, in the method of claim 2, the suction absorption performed to the mid portion between the pair of opposing edges is relieved, after mechanically maintaining the mid portion at a lower portion of the location of the mid portion mechanically supporting one end which becomes a free end of the pair of opposing edges of the other substrate.

【0015】 According to the invention described in claim 4, in the method of claim 1 or claim 2, the respective edge portion of the substrate which becomes a free end is electrostatic absorbed by the pressurizing plate after ascended to a location where the electrostatic absorption force of the pressurizing plate reaches.

【0016】 According to the invention described in claim 5, one substrate to be stuck is arranged on a table located at lower side in a vacuum chamber, and the other substrate is maintained by electrostatic absorption to a pressurizing plate located in the vacuum chamber, the plate opposing to the a substrate loading surface of the table, and wherein respective substrate are stuck to each other by reducing intervals formed between the substrates in vacuum and by using adhesives applied on any one surface of the respective substrate, the apparatus is characterized by comprising: means for maintaining the other substrate over whole surface in an atmosphere by performing electrostatic absorption with the pressurizing plate; means for mechanically maintaining a mid portion of the other substrate between a pair of opposing edges of the other substrate; means for relieving the suction absorption applied over the mid portion of the pair of opposing edges after relieving the suction absorption of the remained opposing edges in the other substrate to make the respective edge be free end; means for

applying electric voltage for electrostatic absorption to the pressurizing plate after achieving a desired degree of vacuum in the vacuum chamber; and means for supporting the other substrate over whole surface thereof through performing electrostatic absorption with the pressurizing plate by maintaining the remained opposing edges of the other substrate, which become free end, by means of performing electrostatic absorption with the pressurizing plate in sequence, the other substrate being maintained to be absorbed by suction absorption in the mid portion thereof of the pair of opposing edges with the pressurizing plate.

【0017】 According to the invention described in claim 6, in the assembling apparatus for substrates of claim 5, the pressurizing plate includes means for performing suction absorption of an area formed of the mid portion between the pair of opposing edges of the other substrate, and means for performing suction absorption of an area formed at respective remained opposing edges of the other substrate.

【0018】

【Embodiment of the Invention】

An embodiment of an apparatus for assembling a substrate according to the present invention will now be explained with reference to the appended drawings below. FIG. 1 is a schematic view for showing a structure of an apparatus for assembling a substrate of the present invention, FIG. 2 is a planar view for showing a vacuum chamber in the apparatus for assembling the substrate shown in FIG. 1, FIG. 3 is an enlarged view of main portions for showing a structure of a supporting claw mechanism (supporting body) in the vacuum chamber shown in FIG. 2, FIG. 4 is a view for showing a table, a pressurizing plate, and an assistant claw mechanism (assistant body) in the vacuum chamber shown in FIG. 2.

【0019】 The assembling apparatus for a substrate according to the present invention 100 includes a device, a stage portion S1, a substrate assembling portion S2, and a stage portion S3 moving in the Z axis direction. A frame 3 is arranged on a foot plate 1 for supporting the stage portion S3 moving in the z axis direction with a frame 2, which supports the substrate assembling portion S2, and a stage portion S1 is provided on a surface of the foot plate 1.

【0020】 An X stage 4a with a driving motor 5 is provided at the stage portion S1, to thereby enable a Y stage portion 4b arranged on the X stage 4a to move in the X axis direction by the motor 5. Also, the Y stage 4b is provided with a driving motor 6 to thereby move a Z stage 4c arranged on the Y stage 4b to the Y axis direction crossing the X axis and the Z axis shown in FIG. 1 by the motor 6. Further, a supporter 9a is arranged on the Z stage 4c with a driving motor 8 to support a shaft 8 to thereby rotate the supporter 9a with regard to the Y stage 4b via the rotation bearing 7 by the driving motor 8.

【0021】 A table 10 is arranged on an upper end of the shaft 9 to support a lower substrate. Also, and lower end of a vacuum bellows 12 is fixed to the Z stage 4c via an arm 11. Because a sealed supporter 13 with a vacuum seal is fixed to the shaft 9 by means of the rotation bearing 7 via the arm 11, the shaft 9 assures good rotation and airtight property, and concurrently the arm 11 and the vacuum bellows 12 are made not to rotate with the rotation of the shaft 9, despite the rotation of the shaft 9.

【0022】 In addition, the substrate assembling portion S2 includes a vacuum chamber 14, a table 10 arranged in the vacuum chamber 14, a pressurizing plate 15, as will be explained below, a supporting claw mechanism 40 for supporting and lifting the substrate, and a gate valve 16 arranged at an inlet of the vacuum

chamber 14. In this instance, as shown in FIG. 1, the pressurizing plate 15 is fixed to the stage portion S3 moving in the Z axis direction via the shaft 25. The shaft 25 is enclosed by the vacuum chamber 26 to maintain vacuum state in the vacuum chamber 14.

【0023】 A piping 20 is arranged under the vacuum chamber 14 for vacuum discharge to be connected to a vacuum pump (not shown) via a change valve (not shown). Also, a piping 21 and a band change valve 22 are provided above the vacuum chamber 14 to make the vacuum chamber from vacuum state to be atmospheric state. Further, an window is formed above the vacuum chamber 14 to observe an alignment mark (not shown) for aligning and sticking two sheets of substrates. Via the window 23 and an opening for sensing the mark of the pressurizing plate 15, difference of the position alignment mark of both the upper and the lower substrates is measured by a sensing camera 24, and based on the obtained results, position alignment is performed to modify the position difference of both substrates.

【0024】 Then, the construction of the vacuum chamber 14 will be explained in detail in connection with FIG. 4. The table 10 is provided with an absorption opening to vacuum absorb the lower substrate, and the absorption opening is connected to an absorption valve (not shown) arranged outside of the vacuum chamber 14 via a piping 17. Also, the table 10 is provided with electrostatic zippers 10a to 10c for electrostatic absorption so that the lead lines are exposed to outside of the vacuum chamber 14 as a main electrode and an assistant electrode.

【0025】 While, a plurality of suction absorption openings 18a, 18b, 18c of the pressurizing plate 15 are connected respective absorption valve (not shown)

outside of the vacuum chamber 14 via piping 19a, 19b, 19c. Also, the absorption areas of the respective suction absorption openings 18a to 18c are arranged to be directed to the right, center and left direction respectively, for example, as shown in FIG. 4, with regard to the drawing so that the absorption areas of the suction absorption openings 18a to 18c can be changed by the respective absorption valve. Further, as valves are connected to respective piping 19a to 19c for destructing the vacuum, the absorption areas of the substrates can be limited or removed by opening the valves. In addition, as the pressurizing plate 15 is provided with electrostatic zippers 15a to 15c for electrostatic absorption, the lead lines are exposed to the outside of the vacuum chamber 14 as a main electrode and an assistant electrode.

【0026】 Also, the stage S3 moving in the Z axis includes a base 27 moving in the Z axis, a linear guide 28, a ball screw 29, and a electric driving motor 30, thereby lifting the pressurizing plate 15 by means of the base 27.

【0027】 Furthermore, various driving means including from a driving motor 5 to air cylinders 62a, 62b for the stage portion S1, substrate assembling portion S2, and the stage portion S3 moving in the Z axis are controlled by the controlling device not shown.

【0028】 Next, the supporting claw mechanism and the assistant claw mechanism will be explained in connection with the appended FIGs 2 to 4.

【0029】 As shown in FIG. 2, two supporting claw mechanisms 40 are arranged on both side of the substrate in the vacuum chamber 14 respectively, viewing from the gate valve 16, and two assistant claw mechanisms are arranged before and inner of the substrate respectively in the vacuum chamber 14, viewing from the gate valve 16.

【0030】 Then, the cofiguration of the supporting claw mechanism 40 will be described below. A supporting claw 41a is arranged above the upper substrate B1 to form an interval between the supporting claws 41a,41b, so that the intervals can be contacted when the upper substrate would be bent, and the supporting claw is fixed to a connection plate 42. As shown in FIG.4 by the dotted line, this is made because the upper substrate B1 can be maintained in a convex state protruding to the upward direction by the supporting claws 41a, 41b. In this instance, the connection plate 42 is mounted on the linear guide 43, which is engaged with the lifting plate 44 to move horizontally in a direction denoted by an arrow (イ) in the drawings. Also, the connection plate 42 is fixed to a linear guide 46 via a fixing device 45, and the linear guide 46 is designed to move up and down along the guide plate 47 as denoted by an arrow (口) shown in the drawing.

【0031】 The configuration will be described in detail below. The guide plate 47 is provided with a through hole for a ball screw 48a, and the ball screw 48a is engaged with a nut 48b, and the guide plate 47 is designed to move horizontally by rotating the ball screw 48a by means of the motor 49. Also, lower portion of the guide plate 47 is prevented from swinging by the rotation of the motor 49, and the linear guide 52 is mounted below the guide plate 47 so that the guide plate 47 can move smooth in the arrow (イ) direction.

【0032】 Furthermore, when the guide plate 47 moves in the horizontal direction by the motor 49, the linear guide 46 can move in the horizontal direction in the drawing, and accordingly the connection plate 42 fixed to the linear guide 46 can move in the horizontal direction of the drawing via the linear guide 43 mounted at the lifting plate 44. That is, the supporting claws 41a, 41b fixed to the connection plate 42 can move in the arrow (イ) direction.

【0033】 In addition, the lifting plate 44 is designed to move up and down along a supporting plate 51 arranged vertically from a bottom plate of the vacuum chamber 14 via a linear guide 50. Rock gears 54 are provided at both ends of the lifting plate 44 so that drive force of the motor 55 can be transferred to the rock gears 54 via a screw tooth wheel 56, a shaft 57, and a pinion gear 58 to thereby move the lifting plate 44 up and down. As described above, the connection plate 42 mounted at the lifting plate 44 can move up and down. That is, the supporting claws 41a, 41b fixed to the connection plate 42 can move in the arrow (口) direction.

【0034】 Then, the assistant claw mechanism 60 will be described in detail below. Assistant claws 61a, 61b are mounted at air cylinders 62a, 62b to be able to move up and down (in an arrow(/\) direction of the FIG. 4) and can revolute in a range of 90°(in an arrow(二) direction in FIG. 2). Also, surfaces of the supporting claws 41a, 41b or the assistant claws 61a, 61b is preferable to be rounded so that the lower surfaces can not be damaged in case of contacting with the lower surfaces of the upper substrate B1.

【0035】 Meanwhile, FIG. 1 will be explained below again. In the drawing, numeral 70 is a control device outputting operating signals to various drive means, which include driving motor 5 and the air cylinders 62a, 62b and the like for the above explained stage portion S1, substrate assembling portion S2, and the stage portion S3 moving in the Z axis. In this case, the operating signals can be outputted depending on the output of detecting sensors mounted at various driving means (not shown) or measured results and the like of the position alignment mark of both the substrates received from sensing cameras 24, and operators of the assembling apparatus 100 will determine whether or not to

output signal signals, a portion of the determination can be made by a sequence program loaded to the control device 70 (something programmed from an appropriate portion of an assembling process as will be described below).

【0036】 From now on, the substrate assembling process performed by the substrate assembling apparatus conFIGured as above will be described in detail below. First of all, the gate valve 16 is opened, and then with employing substrate moving hands of a transferring device (not shown) provided outside of the vacuum chamber 14, the upper substrate B1 is inserted into the vacuum chamber 14 from the gate valve 16 with the film surface of the substrate facing to the downward direction. Next, By using the substrate moving hands, the surface of the substrate B1 is pressed downward from the pressurizing plate 15, and concurrently, the suction absorption of the upper substrate B1 is maintained by means of the suction absorption openings 18a, to 18c of the pressurizing plate 15. After maintaining the absorption of the upper substrate B1 via the above process, the substrate moving hands is migrated from the vacuum chamber 14.

【0037】 Incidentally, the supporting claws 41a, 41b are moved to a height formed between the pressurizing plate 15 and the table 10 by means of the motor 55, and concurrently the supporting claws 41a, 41b are moved to a position receiving the upper substrate B1 by means of the motor 49, and then with employing the substrate moving hands outside of the vacuum chamber 14, the lower substrate B2 is transferred on the supporting claws 41a, 41b. After completing the transfer of the substrate, the supporting claws 41a, 41b loaded with the lower substrate B2 are moved down to a claw interference prevention groove (not shown) formed at the table 10 by means of the motor 55, as a result, the lower substrate B2 can be transferred on the table 10. In this instance, sealing materials are applied on

the peripheral edges of the substrate surface to define a rim previously on the surface of the lower substrate B2 to thereby drop desired amounts of liquid crystal within the areas of the sealing materials.

【0038】 After completing the above described process, the supporting claws 41a, 41b are moved in the far away direction from the horizontal table 10 by means of the motor 49, and will be in a standby state. Also, after migrating the substrate moving hands to outside of the vacuum chamber 14, the gate valve 16 is closed.

【0039】 Then, the assistant claws 61a, 61b are lifted by means of the air cylinders 62a, 62b, and are revolved to 90 degrees to the upper ends, and then lowered. Thus, the lower substrate B2 becomes to be interposed between the assistant claws 61a, 61b and the table 10. At this state, the lower substrate B2 is vacuum absorbed to the table 10 by employing the suction absorption piping 17 of the table 10. In this instance, the lower substrate B2 is interposed between the assistant claws 61a, 61b and the table 10 so that the lower substrate B2 cannot move with regard to the table 10, when the small amount of air remained between the table 10 and the lower substrate B2 is discharged in the process of performing pressure reduction in the vacuum chamber 14.

【0040】 After vacuum absorbing the lower substrate B2 to the table 10, the supporting claws 41a, 41b positioned at a height formed between the pressurizing plate 15 and the table 10 is moved horizontally to thereby ascend the supporting claws 41a, 41b till the supporting claw 41a can contact the lower surface of the upper substrate B1, which is suction absorbed to the pressurizing plate 15. Also, since the upper substrate B1 is absorbed to the pressurizing plate 15 horizontally and the supporting claw 41b is located below the supporting claw

41a by a distance d, the supporting claw 41b do not contact the lower surface of the upper substrate B1 in this instance.

【0041】 After the contacting of the upper substrate B1 with the supporting claw 41a, both the suction absorption openings 18a, 18c of the three suction absorption areas formed at the pressurizing plate 15 are damaged of vacuum, and only the mid absorption opening 18b is maintained at the suction absorption state. Whereby, the upper substrate B1 is bent by its weight to lower both ends of the upper substrate B1. That is, the upper substrate B1 is formed to be a convex shape with positioning the binding place of the supporting claw 41a in the center of the substrate. Accordingly, as shown in FIG. 4 as a dotted line, the peripheral edges of the upper substrate B1 in the gate valve 16 side can be loaded on the supporting claw 41b. Then, the vacuum of the center suction absorption opening 18b formed at the pressurizing plate 15 will be removed.

【0042】 Further, after completing the above explained process, discharge of the vacuum chamber 14 is initiated by utilizing the vacuum pump connected to the piping 20 to thereby reduce the pressure of in the vacuum chamber 14. When the vacuum degree of the vacuum chamber reaches a desired degree, the electrostatic absorption between the pressurizing plate 15 the upper substrate B1, and the electrostatic absorption between the table and the lower substrate B2 is performed. In this instance, as the lower substrate B2 is loaded on the table 10 directly, it is fixed as it was by converting the suction absorption into the electrostatic absorption.

【0043】 Meanwhile, because the upper substrate B1 is designed to protrude to form a convex shape by the supporting claws 41a, 41b, the upper substrate B1 can not be absorbed to the pressurizing plate 15 horizontally through merely

performing the electrostatic absorption of the pressurizing plate 15. As a result, at first, the electrostatic zipper 15b formed at mid of the substrate is operated to perform electrostatic absorption of the mid portion of the substrate. Then, by ascending the assistant claw 61a arranged at the gate valve 16 side, a hanging portion of the upper substrate B1 in the gate valve 16 side is moved upward, which is suppressed from bending by means of the supporting claw 41b. After the hanging portion of the upper B1 substrate is moved to approach the pressurizing plate 15 within the distance wherein the electrostatic absorption force can act, and when electric voltage is applied to an electrostatic zipper 15a, the gate valve 16 side of the upper substrate B1 can be fixed and maintained to the pressurizing plate 15 by means of electrostatic absorption. Then, with regard to an opposed hanging portion of the upper substrate B1 in the gate valve 16 side, after it is moved to approach the pressurizing plate within the distance wherein the electrostatic absorption force act by ascending the assistant claw 61b, and then electric voltage is applied to the electrostatic zipper 15c to thereby perform electrostatic absorption of the hanging portion of the substrate to the pressurizing plate 15 so that the hanging portion of the upper substrate B1 opposing the gate valve 16 can be electrostatic absorbed to the pressurizing plate 15. Accordingly, the upper substrate B1 can be electrostatic absorbed to the pressurizing plate 15 horizontally.

【0044】 In this instance, in case of the electrostatic absorption process of the upper substrate, although the upper substrate B1 becomes to be supported by the supporting claws 41a and the assistant claws 61a, 61b when the assistant claw 61b, which is not suppressed to bend by the supporting claws, is previously ascended before the ascending of the assistant claw 61a, or when the assistant

claws 61a, 61b are simultaneously ascended to the pressurizing plate 15, the convex shape of the substrate protruding upwardly is reversely transformed to form concave shape. As a result, the distance from the concave portion to the pressurizing plate 15 becomes farther so that the upper substrate B1 cannot electrostatic absorb the pressurizing plate 15 horizontally. Accordingly, the assistant claw 61a located at the supporting claw 41b is ascended at first so that reverse transformation cannot be produced. When the electrostatic zipper 15a electrostatic absorbs the gate valve 16 side of the upper substrate B1, the upper substrate B1 is prevented from producing reverse transformation appearance and the upper substrate B1 is maintained to be horizontal by the pressurizing plate 15, even though the remaining portion of the upper substrate side is ascended by the assistant claw 61b.

【0045】 Further, although the electric voltage is applied in sequence to respective electrostatic zippers 15a, 15b, and 15c, in the process of electrostatic absorption, as the upper substrate B1 is protruded upwardly to form convex shape by means of the supporting plate 41a, 41b and the electrostatic absorption force cannot be brought about in the concave portions of the substrate except the mid portion thereof, it is good to apply electric voltage to the other electrostatic zippers 15a, 15c simultaneously with applying the electric voltage to the electrostatic zipper 15b.

【0046】 As described above, after the upper substrate B1 is electrostatic absorbed to the pressurizing plate 15, and the lower substrate B2 is electrostatic absorbed to the table 10 respectively, the claws are located at standby position after the assistant claws 61a, 61b are rotated to be discharged from the surface of

the substrate, or the supporting claws 41a, 41b are moved in the horizontal direction to be far away from the substrate.

【0047】 At this state, the moving base 27 is lowered in the Z axis direction by means of the electromotor 30, and the upper substrate B1 becomes close to the lower substrate B2. In this instance, the position alignment marks attached to respective substrate B1, B2 are detected by means of the sensing camera 24, and the position difference between the substrates is measured. The stage portion S1 is controlled based on the measured value obtained through the above process, and the lower substrate B2 is moved to a desired position to perform alignment of the upper substrate B1 and the lower substrate B2 so that the upper substrate B1 and the lower substrate B2 can be attached and fitted properly.

【0048】 After completing the position alignment, the moving base 27 is still more lowered in the Z axis direction, and the upper substrate B1 is overlapped on the lower substrate B2 on which the sealing materials are applied previously. Then, the sticking attachment of the substrate in which the liquid crystal is sealed, is performed in the range where the sealing materials are applied. Also, after attaching the substrates, it is desirable to maintain the alignment of the upper substrate B1 and the lower substrate B2, and it is also desirable to previously apply adhesives having photo-hardening property on a film surface of the substrate.

【0049】 After the assembling process, electric voltage application to the electrostatic zippers 15a to 15c is stopped and the base 27 moving in the Z axis direction is ascended, and then the electric voltage application to the electrostatic zipper of the table 10 is stopped, and concurrently the converting

valve 22 for the bends is opened to result in forming atmospheric pressure in the vacuum chamber 14.

【0050】 After forming atmospheric pressure in the vacuum chamber 14, the gate valve 16 is opened to thereby open the vacuum absorption opening 17 of the table 10. Then, the cell is ascended by means of the supporting claws 41a, 41b, and the moving hands of the substrate transferring device (not shown) is inserted below the cell to thereby migrate the cell on the substrate moving hands, and then the cell is taken out from the vacuum chamber 14 by withdrawing the substrate moving hands.

【0051】 In this instance, when the vacuum chamber 14 is changed from vacuum state into atmospheric state, air stream is produced in the vacuum chamber 14, and the cell on the table 10 happens to migrate by means of the air stream. When the cell on the table 10 has migrated, even if it is tried to transfer the cell on the substrate moving hands by lifting the cell with the supporting claws 41a, 41b, it is impossible to lift the cell because the cell is out of alignment from the supporting claws 41a, 41b. Accordingly, it is desirable to lightly hold the cell between the assistant claws 61a, 61b which is withdrawn and the table 10 at the time of discharging the air in the vacuum chamber 14.

【0052】

【Effects of the Invention】

As described above, according to the method and apparatus for assembling a substrate of the present invention, although the size of the substrate becomes larger and thinner, it is possible to manufacture the substrate with long durability without remaining any distortion on the substrate.

【Description of Drawings】

FIG. 1 is a schematic view for showing a structure of an apparatus for assembling a substrate of the present invention;

FIG. 2 is a planar view for showing a vacuum chamber in the apparatus for assembling the substrate shown in FIG. 1;

FIG. 3 is an enlarged view of main portions for showing a structure of a supporting claw mechanism (supporting body) in the vacuum chamber shown in FIG. 2; and

FIG. 4 is a view for showing a table, a pressurizing plate, and an assistant claw mechanism (assistant body) in the vacuum chamber shown in FIG. 2.

【Explanation on Numerals】

100: substrate assembling apparatus

S1: stage portion

S2: substrate assembling portion

S3: stage portion moving in the Z axis direction

B1: upper substrate B2: lower substrate

10: table (table in the lower side)

14: vacuum chamber

15: pressurizing plate (table in the upper side)

15a – 15c: electrostatic zipper 16: gate valve

18a - 18c: suction absorption opening

40: supporting claw mechanism portion

41a, 41b: supporting claw

60: assistant claw mechanism portion

61a, 61b: assistant claw